Evidence-based librarianship: an overview

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Objective: To demonstrate how the core characteristics of both evidence-based medicine (EBM) and evidence-based health care (EBHC) can be adapted to health sciences librarianship.

Method: Narrative review essay involving development of a conceptual framework. The author describes the central features of EBM and EBHC. Following each description of a central feature, the author then suggests ways that this feature applies to health sciences librarianship.

Results: First, the decision-making processes of EBM and EBHC are compatible with health sciences librarianship. Second, the EBM and EBHC values of favoring rigorously produced scientific evidence in decision making are congruent with the core values of librarianship. Third, the hierarchical levels of evidence can be applied to librarianship with some modifications. Library researchers currently favor descriptive-survey and case-study methods over systematic reviews, randomized controlled trials, or other higher levels of evidence. The library literature nevertheless contains diverse examples of randomized controlled trials, controlled-comparison studies, and cohort studies conducted by health sciences librarians.

Conclusions: Health sciences librarians are confronted with making many practical decisions. Evidence-based librarianship offers a decision-making framework, which integrates the best available research evidence. By employing this framework and the higher levels of research evidence it promotes, health sciences librarians can lay the foundation for more collaborative and scientific endeavors.

The evidence-based movement has emerged in the past few years in response to changes in the health care arena [1, 2]. Signaling this new orientation, many diverse disciplines and specialties have begun to attach the term evidence-based to their titles: cardiology, pediatrics, surgery, nursing, gastroenterology, diagnostic radiology, disease management, pathology, midwifery, complementary or alternative medicine, and health policy. The two principal evidence-based movement journals, *ACP Journal Club* and *Evidence-Based Medicine,* are quickly gaining recognition as core journals in clinical medicine [3–14]. Other specialties [15–17] have also formed their own journals.

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The movement originated as evidence-based medicine (EBM) and recently has been eclipsed somewhat by a much broader movement, referred to as evidence-based health care (EBHC). EBM still retains considerable methodological rigor whereas EBHC seems to offer greater flexibility and adaptability to disciplines outside clinical medicine. At this stage, EBM has been more clearly and comprehensively articulated by its advocates than has EBHC. The new book *Narrative Based Medicine* [18] suggests that there may even be the formation of at least one splinter movement. After a decade of intense activity and increased acceptance as a framework for decision making, both the EBM and EBHC movements represent a major directional change rather than another passing fad in the health care arena.

The proliferation of so many evidence-based special-

ties appears to bode well for health sciences librarians. After all, librarians have positioned themselves as the experts at searching for the evidence needed for each of these elements in the larger EBHC movement [19–32]. Health sciences librarians apparently even played a role in attempts [33] to implement aspects of EBM during the 1920s. The EBHC movement nevertheless expects each area in health care to supply the necessary evidence to support its ongoing activities and operations. Cardiologists must have the evidence at hand to support their decisions to employ procedures, such as a catherization. Librarians similarly are called upon with increasing frequency to provide the requested evidence to continue provision of their collections, operations, or services. No wonder, then, that MLA President J. Michael Homan has identified the need to ''foster evidence-based librarianship'' as a major goal [34].

Evidence-based librarianship (EBL) adapts its core characteristics from the EBM and EBHC movements. EBM, in particular, offers some of the most powerful research designs available, such as randomized controlled trials and a decision-making framework that have been largely untapped by health sciences librarians. In clinical medicine, these research methods are intended to establish causal relationships while minimizing systematic or human biases. Until recently, health sciences librarianship has been largely influenced by research designs developed in the social, behavioral, and management sciences. Theoretical approaches developed in humanities disciplines, such as history or philosophy, have also influenced the field. EBL now seeks to adapt rigorously tested research designs from the health sciences, particularly clinical medicine.

To adapt core characteristics from EBM does not imply that EBL imitates EBM, or even EBHC, blindly. EBM focuses upon a disease-based model of decision making, whereas EBHC has a different type of appeal to health sciences librarians due to its flexibility in choice of methods and its similar service models. EBL incorporates the decision-making framework, the basic process, and many of the same research methods as EBM as a means to improve library practices [35–37]. EBL employs the best available evidence based upon library science research to arrive at sound decisions about solving practical problems in librarianship. EBL also enables health sciences librarians to practice the broad goal of continual, lifelong, self-directed learning while improving their practices. Unique circumstances in librarianship lead to a few intentional variations from the standard EBM approaches [38–41].

This article describes how the core characteristics of EBM and EBHC can be adapted to EBL. The author makes no claim to offer the definitive statement of what EBL should mean. This proposed framework remains largely speculative at this stage in its development. Only a continuous dialogue within the profession will produce such a consensus. The concept of EBL [42–46] preceded coinage of the actual term ''evidence-based librarianship'' [47] by several years, just as the concept of EBM preceded the published term ''evidence-based medicine'' [48–50]. In other words, both EBL and EBM are dynamic and evolving approaches to integrating research into practice. This article offers a conceptual framework to stimulate a dialogue; EBM and EBHC core characteristics and approaches are briefly reviewed and then followed by illustrations of how these approaches apply to health sciences librarianship. Because most health sciences librarians are already familiar with many of the core characteristics of EBM and EBHC, this article will avoid detailed explanations of either EBM and EBHC. The author has made sufficient references to original EBM and EBHC documents to lead the curious reader to in-depth explanations of these core characteristics.

DEFINITION

Evidence-based librarianship seeks to reintegrate the ''science'' back into library science. Davidoff writes:

> Science is cognitive, involving accurate observation and clear description, hypothesis generation, data gathering and interpretation, and the creation of theory. But science is also a state of mind: skeptical, open, balanced, respectful of evidence, thorough, always on the alert for bias. [51]

Library *science* cannot be conceived of as a remote, ivory tower endeavor [52]. Librarians operate their libraries in the real world context of providing services and collections through managing budgets and other resources. Thus, EBL constitutes an *applied* rather than theoretical science. EBL merges scientific research with the pressing need to solve practical problems. And, like the scientific method, EBL provides a framework for self-correction as new information becomes available that suggests new directions or methods.

EVIDENCE-BASED MEDICINE (EBM) AND EVIDENCE-BASED HEALTH CARE (EBHC) CORE CONCEPTS

Evidence-based medicine shares with librarianship the goal of applying the best scientific research toward the immediate, practical need to provide efficient, compassionate medical services to patients. No succinct definition for EBM has yet to be universally agreed upon. EBM is continuously reinvented. One frequently cited definition states that:

> Evidence-based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. [53]

The Evidence-Based Medicine Working Group offers a slightly different definition for EBM:

> Evidence-based medicine de-emphasizes intuition, unsystematic clinical experience, and pathophysiologic rationale as sufficient grounds for clinical decision making and stresses the examination of evidence from clinical research . . . and the application of formal rules of evidence [for] evaluating the clinical literature. [54]

Other EBM advocates indicate that ''expert opinion'' and ''standard practice'' are insufficient bases for clinical decision making, because both of these traditional elements in medical practice often lag far behind the current best evidence [55]. EBM emphasizes the need to develop pragmatic clinical skills, but only when those skills are replenished with evidence systematically gleaned from rigorously conducted research. This goal of lifelong, continual learning has implications for undergraduate, graduate, and continuing medical education. EBM tries to reduce reliance upon the traditional medical model of expert authority, based upon the belief in the validity of cumulative clinical experience. EBM seeks to replace this authority-based model with a scientifically based, pragmatic model for medicine [56–59]. EBM relies upon scientific generalization but still emphasizes the importance of the individual patient's ''characteristics, situations, and preferences'' [60].

Evidence-based health care shares most of the same definitional characteristics as EBM, except it offers more inclusive approaches and a greater diversity of research methods, reflecting the broader array of problems and opportunities found across the continuum of all health care disciplines. EBHC recognizes the strength of the EBM approach and adapts it to diverse health care disciplines outside of clinical medicine. EBHC also emphasizes service models with relevance to librarianship.

A PRELIMINARY CONCEPTUAL FRAMEWORK FOR EVIDENCE-BASED LIBRARIANSHIP (EBL)

The author proposes the following seven-part conceptual framework of EBL:

1. EBL seeks to improve library practice by utilizing the best-available evidence combined with a pragmatic perspective developed from working experiences in librarianship;
2. EBL applies the best-available evidence, whether based upon either quantitative or qualitative research methods;
3. EBL encourages the pursuit of increasingly rigorous research strategies to support decisions affecting library practice;
4. EBL values research in all its diverse forms and encourages its communication, preferably through peer-reviewed or other forms of authoritative dissemination;
5. EBL represents a global approach to information seeking and knowledge development, involving research but not restricted to research alone;
6. EBL supports the adoption of practice guidelines and standards developed by expert committees based upon the best-available evidence, but *not* as an endorsement of adhering to rigid protocols; and
7. In the absence of compelling reasons to pursue another course, EBL adheres to the hierarchy (or levels) in Table 2 (below) for using the best-available evidence, lending priority to higher levels of evidence from the research.

Table 1
The EBL process

1.	Formulate a clearly defined, answerable question that addresses an important issue in librarianship.
2.	Search the published and unpublished literature, plus any other authoritative resources for the best-available evidence with relevance to the posed question.
3.	Evaluate the validity (closeness to the truth) and relevance of the evidence.
4.	Assess the relative value of expected benefits and costs of any decided upon action plan.
5.	Evaluate the effectiveness of the action plan.

The remaining sections of this article will further clarify the meanings of this seven-part conceptual framework of EBL.

THE EBL PROCESS

The EBL process enables health sciences librarians to integrate research findings into their daily practice by focusing upon a specific problem in need of immediate attention. The EBL process consists of formulating a practical question, searching for the evidence needed to answer the question, and systematically evaluating the gathered evidence for its usefulness and validity for answering the initial question. The specific EBL process outlined in Table 1 attempts to combine the scientific rigor of the EBM process with the flexibility found in the EBHC process to address the unique circumstances of health sciences librarianship.

THE EBM AND EBHC PROCESSES

The Evidence-Based Care Resources Group in Canada developed the first version of the EBM process, which included five steps: formulate an important question that can be answered; critically review the best available evidence; estimate the expected benefits, harms, and costs for each alternative; judge the relative value of the expected benefits, harms, and costs; and (optional) develop clinical practice guidelines to efficiently guide similar decisions in the future [61]. Subsequent

Table 2
Levels of EBL evidence

1.	Systematic reviews of multiple rigorous research studies
2.	Systematic reviews of multiple but less rigorous research studies, such as case studies and qualitative methods
3.	Randomized controlled trials (RCTs)
4.	Controlled-comparison studies
5.	Cohort studies
6.	Descriptive surveys
7.	Case studies
8.	Decision analysis
9.	Qualitative research (focus groups, ethnographic observations, historic, etc.)

versions have simply clarified and slightly modified this original articulation of the EBM process. Sackett and Rosenberg emphasize searching prowess and methodological rigor in their steps: convert clinical information needs into answerable questions; track down, with maximum efficiency, the best evidence with which to answer them (whether from the clinical examination, diagnostic laboratory, published literature, or other sources); critically appraise that evidence for its validity and clinical usefulness; apply the results of this appraisal in clinical practice; and evaluate performance. Silagy and Haines offer a nearly identical version of the process, except they emphasize the importance of applying the evidence to treating a specific patient. Hebert and Tugwell emphasize the literature search and its evaluation [62–64]. The EBHC process largely resembles the EBM process. At this early stage in its development, EBHC differs from EBM mostly in its emphasis upon weighing the costs and benefits of any course of action in its process. EBHC also seems to view this process as a more iterative, less linear activity [65, 66].

FORMULATING EBL QUESTIONS

Questions drive the entire EBL process. EBL assigns highest priority to questions with greatest relevance to library practice. The wording and content of the questions determine what kinds of research designs are needed to secure answers. These questions may relate to librarians' individual specialties, their specific libraries, their type of libraries (e.g., hospital), or their entire profession. EBL question formulation deserves an entire article to describe it fully. Two points require emphasis here. First, precision, in terms of clarity and scope of the question, leads to a more efficient search for the needed evidence. As Oxman and Guyatt note, ''Fuzzy questions tend to lead to fuzzy answers'' [67]. Second, because so many initial questions lead to other questions, the question formulation process needs to be viewed as an iterative activity. Effective question formulation in step one of the EBL process leads to efficient searching for the needed evidence [68].

LEVELS OF EVIDENCE

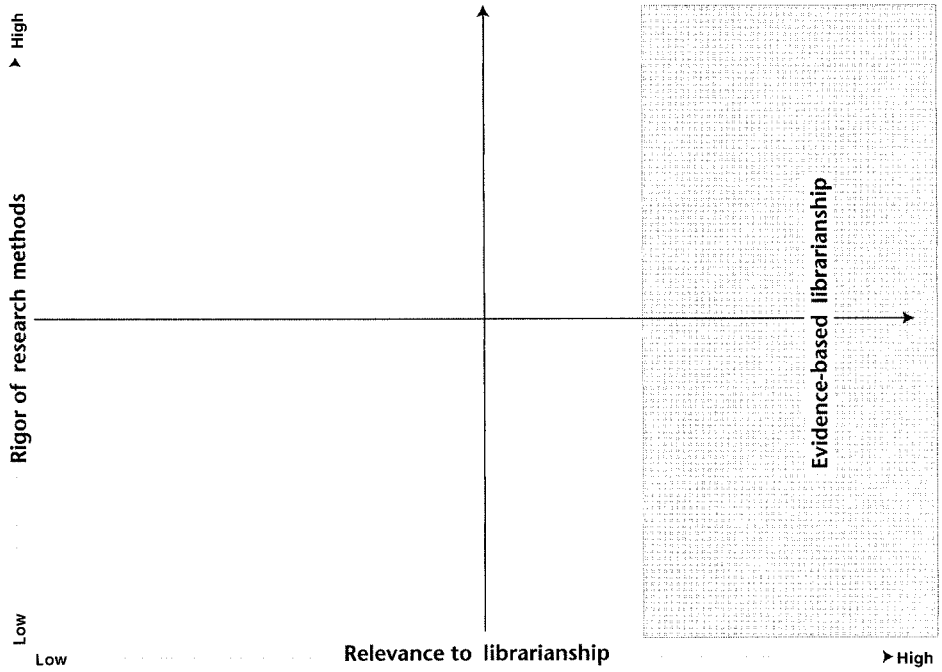
Table 2 offers an EBL hierarchy for evaluating the comparative validity of different forms of evidence. These levels acknowledge the inherent validity of many quantitative and qualitative research methods while establishing the relative reliability and validity of results produced by each method. This hierarchy follows the EBM levels closely due to the sound theoretical bases for the levels that apply to any discipline, whether clinical medicine or librarianship. The EBL levels of evidence in Table 2 take into account the types of management methods needed in library practice that exists on the periphery of clinical medicine. The EBL levels also allow for the flexible integration of other research designs from areas such as the social sciences in possible future revisions. In addition, these levels recognize the current lack of research evidence to support ideal forms of methodological rigor, such as meta-analysis and randomized controlled trials (RCTs), that are found in some areas of clinical medicine. Most importantly, the nine EBL levels of evidence primarily are intended to alert librarians to the inherent human and systematic biases more frequently found and more difficult to control for in the lower levels of evidence.

Aside from the theoretical and methodological advantages, there are also practical reasons for considering use of levels of evidence for librarianship that resemble the levels in EBM. First, any research using these methods for library science situations will have inherently greater credibility to decision makers and possible allies in the broader health sciences arena. Second, using the same methods allows for the greater integration of health sciences librarianship into the larger research domain of health sciences. Finally, by using methods familiar to colleagues outside of librarianship, librarians can open doors to future multidisciplinary collaboration [69]. The methodological soundness for these levels of evidence, specifically the ability of higher levels of evidence to minimize bias, should drive any decision to employ the EBL levels of evidence. Figure 1 presents a tool for reconciling the two key variables in EBL: relevance versus rigor. EBL pursues the dual goals of encouraging research that exhibits both methodological rigor and relevance to practical situations in librarianship. EBL does favor relevance over rigor when evidence from more methodologically valid methods simply is not available. EBL generally lends preference to the higher levels of evidence when evidence from both higher- and lower-level methods are available. EBL requires lending greatest priority, as mentioned above, to the most relevant questions.

EBM LEVELS OF EVIDENCE

The historic influence of clinical epidemiology on the evidence-based movement can be observed most

Figure 1
Evidence-based librarianship



EBL emphasizes evidence with the greatest relevance to librarianship, while encouraging use of higher levels of research evidence whenever possible.

strongly in its attention to EBM levels of evidence. Prior to the first published use of the term ''Evidence-Based Medicine'' [70] in 1991, clinical epidemiologists established the conceptual foundations for what later would become EBM. The Canadian Task Force on the Periodic Health Examination established the first known levels of research evidence for clinical practice in 1979. The highest level of evidence at that time involved at least one RCT. The second highest level involved well-designed cohort or case-control studies; the next level was based on comparisons of outcomes between different times and places, such as where penicillin had been introduced compared to where it had not been introduced. The lowest level consisted of ''Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees'' [71]. These levels resemble the rankings of experimental, observational, and descriptive research designs in epidemiology.

By 1992, the levels of EBM evidence had become more rigorous with ''meta-analysis of randomized controlled trials'' occupying the highest level in a clinical guidelines document prepared by the U.S. Agency for Health Care Policy and Research [72]. The next levels in this 1992 hierarchy resembled the Canadian levels of evidence, reflecting a reliance on time-tested standards for determining comparative methodological rigor. In 1994, the U.S. Preventive Services Task Force [73] outlined levels of evidence that largely resembled the Canadian levels of evidence. The Center for Evidence-Based Medicine (CEBM) at Oxford University in the United Kingdom has posted its latest version of the levels of evidence on its Website [74]. These levels of evidence, while more elaborate, reflected the basic logic found in the previously recommended levels of evidence of minimizing bias while ascending the hierarchy. EBHC levels of evidence [75] consisted of the same methodological hierarchy except that its own hierarchy directed more attention to decision analysis, surveys, and the many forms of qualitative research developed by the social sciences.

EBL LEVELS OF EVIDENCE

The EBL levels of evidence incorporate both the rigor and flexibility of methods offered by the EBM and EBHC levels of evidence, respectively. Much library practice uses methods such as surveys, focus groups, and other qualitative research modalities that the standard EBM levels of evidence typically would not consider. This diversity of methods enables EBL to address some research questions not easily handled by EBM. EBL approaches and methods are intended to be inherently useful in making everyday library decisions.

Decision makers in the health care arena may be more likely to be persuaded by the validity and reliability of the higher levels of evidence. The rigor of the higher EBM levels of evidence still should be a goal for health sciences librarians, given the years it has taken to develop an understanding of the potential biases and relative scientific strength of each of these levels of evidence.

The levels of evidence in Table 2 are not rigid criteria for weighing the relative merits of research reports. Rather, they serve as basic guidelines for comparing different forms of evidence in search of a practical decision in librarianship. Within any level of evidence, there inevitably will be research reports that vary in their adherence to scientific methodological standards [76]. Some lower levels of EBL evidence may contain studies with higher-quality designs or methodological rigor than study designs ranked at the higher levels of EBL evidence. In this connection, a well-designed descriptive survey could have greater validity than a poorly designed or procedurally compromised randomized controlled trial. In addition, some research designs incorporate multiple research methods. For example, a cohort study may include a descriptive survey, or a decision analysis may be based upon quantitative results from randomized controlled trials.

The following sections describe the methods of the nine levels of EBL evidence. The first five levels are described in greater detail, because they are probably less well known to readers than are the lower levels of evidence. A number of studies have analyzed the research literature of library science in the United States [77–84]. These studies have been supplemented on an international scale, including studies in Asia and Africa [85–88]. Several other studies have focused on patterns in the health sciences libraries literature [89–94]. Most of these studies reveal that library research relies primarily upon three levels of evidence: descriptive surveys, case studies, and qualitative methods. Because of the familiarity of these methods to most readers, the author will only review these levels of evidence briefly. The nine levels of evidence are arranged hierarchically by the comparative rigor of each research method. Black has observed that the highest levels of evidence in EBM are neither possible nor desirable in all clinical research [95]. Sackett and Wennberg [96] have made similar points. These observations must be kept in mind for library practice when reviewing the nine levels of EBL evidence.

Systematic reviews

On Table 2, systematic reviews occupy the two highest levels of EBL evidence. Systematic reviews seek to answer important although narrowly defined questions pertaining to library practice. Systematic reviews employ explicitly stated methods for thoroughly searching a relevant literature, then carefully weighing the evidence found in that literature. As with other forms of rigorous scientific activity, systematic reviews are intended to reduce bias [97–101]. Systematic reviews may include, but are not restricted to, meta-analyses. Gray offers a checklist for critically appraising review articles that readers may find useful [102]. Systematic reviews sometimes are utilized to produce clinical guidelines and recommendations for expert panels in clinical medicine [103]. Physicians who use systematic reviews do appear to modify their practice [104]. Systematic reviews differ significantly from the still commonly found narrative review in the clinical medicine literature [105]. Narrative reviews often answer broad, rather than specific questions posed by authors. In the medical literature, narrative reviews still form the basis for many textbook chapters and literature reviews. Narrative reviews lack descriptions of the literature search methods employed by the authors and synthesize the literature in ways that may introduce the authors' biases [106, 107].

No meta-analysis currently exists for health sciences librarianship at this highest level. At this time, meta-analysis generally cannot even be considered a viable method for resolving discrepancies between research studies in librarianship. Saxton's recent attempt to conduct a meta-analysis on general reference-evaluation studies, which yielded limited results, drives home this point [108]. The attention paid by health sciences librarians to increasingly rigorous research methodologies suggests that a well-designed meta-analysis in our area of librarianship could develop within the next three to five years. The absence of such a productive meta-analysis does *not* negate the strength of this type of research method for making sound decisions. Thus, this method should still occupy the highest level in the hierarchy.

Readers may want to consult Light and Pillemer's book *Summing Up* for some creative ideas about how to conduct level-2 evidence research involving systematic reviews [109]. Slavin also has developed an alternative to meta-analysis [110, 111], although a common fallacy when combining small numbers of studies has to be avoided [112]. Booth and his colleagues in the United Kingdom have been exploring the use of systematic reviews to address practical library decision-making situations [113, 114]. Two physicians conducted a systematic review on the efficacy of physician database searching, which has high relevance for librarians [115].

Randomized controlled trials (RCTs)

Randomized controlled trials (also called ''randomized clinical trials'') represent the most rigorous form of single research study. RCTs incorporate three elements: (1) subjects, usually patients in clinical medicine research studies, who are assigned to one of two or more groups that may be subjected to different in-

terventions or simply the lack of an intervention such as a placebo; (2) researchers assign each subject to a particular group based solely upon chance; and (3) all subjects in the different groups are studied to measure the effects, if any, of the intervention [116]. The experimental group, which receives the intervention, must resemble the control groups in every appropriate way to maintain validity of an RCT. Only by controlling all relevant variables can the researchers detect any outcomes of the intervention [117]. RCTs employ prospective approaches, meaning that their designs call for the researchers to follow the participants from one point in time forward [118]. There are many time, resource, compliance, and ethical challenges to conducting RCTs [119–122]. As one example, would it be ethical to deny some users access to a needed library intervention (such as the use of an online catalog or references services) simply to create a control group? The typical methodological rigor of RCTs nevertheless positions them to be the ''Gold Standard'' for decision making in evidence-based practice.

RCTs in librarianship are difficult to identify because librarians usually do not label their research in these terms. Part of the problem may be due to insufficient statistical reporting methods [123]. Three prominent studies illustrate the power of RCTs in librarianship, however. Marshall and Neufeld conducted an RCT in 1981 that studied the quality of information-seeking skills in health care professionals who were either exposed or not exposed to an intervention (a clinical librarian). This RCT found that the intervention of a clinical librarian increased use of health sciences libraries [124]. Haynes, Ramsden, McKibbon, and Walker used the RCT method to determine the effect of MEDLINE fees on user access [125]. This study discovered that user fees did not affect the quality of online searches by non-librarians. This study did reveal, though, that those searchers who were charged a fee searched significantly less than those searchers who were not charged a fee. In a third RCT, medical students were randomly assigned either to receive or not receive a three-hour database-searching instructional intervention. Medical students who received the instructional intervention performed significantly better database searches than the students in the control group [126].

Controlled-comparison studies

A form of comparison study in medicine, known as the case-control study, looks at outcomes and tries to trace them to previous defining circumstances. Lichtenstein, Mulrow, and Elwood describe the process of a case-control study: ''persons with a particular condition are identified (cases), a series of persons without the condition selected (controls) and the existing or prior exposures or characteristics of the two groups compared'' [127]. Researchers in clinical medicine typically study the members' health histories in each group in search of a putative cause for disease in the first group [128]. Because of the risk of bias in these studies, researchers gravitate toward collecting more objective forms of data found in medical records rather than primarily relying upon patients' personal accounts of their health histories. Case-control studies are designed to establish possible causes for a condition. For example, a case-control study may look at how certain patients with lung cancer (cases) differ from another group (controls) who otherwise resemble these patients. This study could determine that all or most of the lung cancer patients are smokers (a possible cause), whereas few controls are smokers. This difference may explain the cases with lung cancer. Case-control studies in medicine normally take a retrospective approach, meaning that they examine a present condition by looking back at past events to identify causative factors for disease [129]. There are numerous strategies for reducing bias in case-control studies [130–132].

The author knows of no study in health sciences librarianship that precisely duplicates a case-control study design in medicine. Yet, a similar application in librarianship would substitute a disease condition with a non-pathologic outcome in a library environment. For example, one could study different end-user physician or medical-student searchers. One could examine the backgrounds of searchers classified as highly proficient (cases) and then compare them to far less proficient searchers (controls) who otherwise resemble the proficient searchers. This approach may turn up differences between the groups of searchers that explains why some searchers are more proficient than others. Similarly, another case-control study could examine the possible reasons why some students are more frequent library users (cases) than other students (controls).

Controlled-comparison studies in librarianship may be thought of as a specific subtype of comparison study, which resemble case-control studies in medicine in some ways. General comparison studies in librarianship examine all sorts of different groupings and analyze their differences, often in a descriptive manner. Controlled-comparison studies are distinguished from mainstream comparison studies in their attempt to match cases and controls in most, or all, relevant ways. The controlled-comparison study draws its strength from matching cases and controls to minimize the alternative explanations for the different outcomes. The cases and controls are not randomized, however. In this way, they may be thought of as ''non-randomized controlled trials'' (NRCT) applied in circumstances in which RCTs are impractical or unethical. The sequence of observed events normally differs as well: cases and controls are identified at the beginning of the study in EBL rather than as outcomes as seen in EBM. These designs potentially use a more flexible research design than their counterparts in

Table 3
Examples of controlled comparison studies

First author	Year	Subject
D'Alessandro MP	1998	Response times for three different types of network connections [136]
Eldredge JD	1997	Differences between peer-reviewed journals lists found in two serials sources [137]
Halletts KS	1998	Nine searches using controlled vocabulary strategies in MEDLINE via either Dialog or Ovid [138]
McKnight M	1999	Interlibrary loan availability of nursing journals in five states [139]
Stone VL	1998	Ten reference questions about natural products used as drugs searched via eight databases [140]

medicine, because library research generally does not focus primarily upon negative [133] or pathophysiological conditions such as disease. Controlled-comparison studies in librarianship can employ either prospective or retrospective strategies as long as groups of cases and controls are legitimately matched. Conceivably, some benchmarking projects could be loosely defined as forms of controlled-comparison study [134, 135]. Table 3 offers examples of controlled-comparison studies, based upon a reading of the methods sections found in these articles.

Cohort design studies

In clinical medicine, cohort studies normally study a group of people who potentially share one or more characteristics such as common experiences or conditions [141]. These common experiences may include their age, sex, geographic locale, exposure to a disease or substance, or an intervention. Cohort studies seek to describe possible causal links and pose probabilities of risk. The Framingham Study of coronary heart disease has been one of the largest and well-known cohort studies in the United States [142]. Cohort studies collect data with either concurrent or historic approaches, depending upon the sequence in which researchers begin to study the cohort. Prospective cohort studies (sometimes called ''concurrent cohort studies''), such as the Framingham Study, normally begin to measure relevant indicators of variables *prior* to an exposure or incidence of disease. These measurements continue throughout the study until a certain endpoint. Retrospective cohort studies (sometimes called ''historic cohort studies'') identify the cohort, their exposure, and outcomes *afterward,* as a follow-up study [143]. Regardless of data-collection approach, all cohort studies infer causality between a condition during an earlier period to a condition at a later period. An epidemiologic cohort study must include members of a population that has been exposed to a factor of interest that will be compared to members of the same (or similar) population, which has not been exposed to a factor of interest. Outcomes between the two (or more) groups are then compared in the analysis.

Although EBL emphasizes adaptations from EBM or EBHC research designs, cohort studies are quite prevalent in other disciplines. The social and behavioral sciences have employed cohort studies to understand better phenomena as diverse as childhood development, political participation, childlessness, substance abuse, prenatal or early childhood exposures leading to mental illness in later life, characteristics of the digital generation, and psychological stress in the workplace. The biological and earth sciences have employed cohort studies to understand better elements as diverse as Atlantic cod, evergreen trees, dogs, seals, and even fossilized extinct species [144].

Cohort studies in librarianship are fairly popular. Cohort studies in both medicine and librarianship describe possible causal relationships of variables across time involving designated groupings. Instead of centering on probable risk as in medicine, though, cohort studies in librarianship focus on probabilities of outcomes. Interestingly, librarians rarely identify these projects as cohort studies. There are two major types of cohort-study design in librarianship: (1) user-population cohort designs and (2) collections or resources use cohort-study designs. Table 4 offers a representative sample of the diverse applications of the cohort-study design in health sciences librarianship. Table 4 should not be considered to be a comprehensive inventory, because it does not include numerous other examples from librarianship of either major type of cohort study.

Descriptive surveys

As already noted, descriptive surveys are one of the most popular modes of conducting library science research. Surveys can be employed for higher levels of EBL research to describe the opinions, characteristics, or experiences of a group. For example, a descriptive survey may be employed in combination with a cohort study. Probably the most famous and well-conducted survey in health sciences librarianship is the Rochester Study, which shows the importance of libraries to medical outcomes [155]. The library literature offers many excellent examples of other well-designed and well-conducted descriptive surveys. Less formal surveys also may answer practical questions [156]. Even citation analysis can be considered a form of descriptive survey. Yet, surveys often are far more complex enterprises than they appear on the surface. The author recommends the *Survey Kit* series, published by Sage [157], as a source of practical advice on conducting surveys, which are more likely to be both valid and reliable.

Table 4
Diverse examples of cohort study designs in EBL

User population studies		
Defined population	**Exposure/Non-exposure**	**Outcome(s)**
Medical students at the University of Miami	MEDLINE instruction by librarians for incoming students	Performance on exam during third year [145]
Students at 4 medical schools	Problem-based learning (PBL) curricula	Frequency and types of library use [146]
Nursing students	Influence of friends, faculty, peers, and librarians	Comfort with utilizing computers [147]
Physicians in south Texas	Proximity to an academic health sciences library	Use of MEDLINE and libraries [148]
Faculty at the University of Illinois–Chicago (UIC)	Exposure to new electronic resources	Changes in information-seeking behavior [149]
Collection or resources use studies		
Defined population	**Exposure/Non-exposure**	**Outcome(s)**
500 consecutive email messages submitted to the Digital Health Sciences Library	Use of DHSL	Types of information requests [150]
1,224 document delivery requests from rural health care professionals	Outreach projects	Diverse subjects and 547 unique journal titles requested [151]
Articles indexed by MEDLINE 1989–1991	Presence of structured abstracts	Number of assigned MeSH terms [152]
1,958 books added during 1993–1994 at UIC	Availability on shelves	81% circulated within three years [153]
194 journal titles at USC	Both print and electronic versions available	Use study in progress [154]

Decision analysis

Although the seventh level of EBL evidence has rarely been employed in health sciences librarianship, decision analysis has been utilized in academic librarianship [158]. In health management and public policy analysis, however, decision analysis has been quite popular for resolving conflicting information [159]. The most popular vehicle for decision analysis has been the ''decision tree'' model, which enables decision makers to follow the probabilities and outcomes of a particular course of action. An article by Richardson and Detsky offers a clear introduction to decision trees [160]. This method has proved useful in handling complex decisions involving immunization policies [161] or navigating the ethical uncertainties of physician-assisted suicide [162].

Case studies

Case studies are one of the most popular descriptive research methods employed by librarians, as observed above. Case studies use opportunities that occur frequently in librarianship and require only observational skills rather than expensive or elaborate measurement techniques, just as case reports in medicine allow physicians to integrate valuable observations into everyday practice [163]. Case studies therefore enable librarians to circumnavigate many of the time and cost constraints of other research designs. Case studies describe with varying degrees of detail and objectivity a series of experiences in a library or a library program. They also vary greatly in rigor and degree of quantification. Case studies containing greater quantification tend to be easier for third parties to evaluate with greater objectivity.

Many issues of the *Bulletin of the Medical Library Association, Health Libraries Review, Medical Reference Services Quarterly,* or *Bibliotheca Medica Canadiana* contain at least one case study. One of the major drawbacks of case studies in librarianship is their overwhelming positive-outcome bias. To place this eighth level of evidence in perspective, the reader most likely cannot recall ever reading about a library or a library program that is described as a major failure. Line has criticized this deficiency to the case study method in the broader literature [164]. While some librarians may want to review case studies to learn about what types of programs have been successful, the absence of less successful programs as described in the library literature has the inadvertent effect of not alerting librarians to the educational lessons learned from others' failures. This omission consequently can lead some librarians to repeat failures experienced elsewhere. Case studies commonly have exploratory, descriptive, or explanatory purposes. There are many forms of bias when conducting case studies, a detracting aspect that offsets many of the conveniences with researching at this level of evidence [165].

Qualitative research

Health sciences librarians have explored the use of at least three forms of qualitative methods: ethnographic, focus group, and historic. These qualitative methods are most helpful for developing hypotheses or testing hypotheses in circumstances where higher levels of evidence are difficult to apply [166]. Qualitative research has not really been explored to the same extent in EBM. Many of the pioneering studies in other fields, such as psychology, were qualitative studies involving small numbers of subjects. Piaget's work in child development is only one noteworthy example of the significant contributions of these research types of designs.

Qualitative research has attracted great interest in librarianship, although these methods have not been explored extensively. Some focus group experiences have been documented [167–169]. McKnight and Peet moreover have synthesized the ethnographic studies

about information-seeking behaviors [170]. Qualitative methods can yield many benefits for librarians in developing hypotheses or in studying unique circumstances in which quantifiable methods would be inappropriate [171]. Some librarians object to the relative positioning of qualitative methods in this ranking of evidence. This ranking stems not from any fault or skill limitations of researchers in applying qualitative techniques. Instead, these designs invite possible biases that are often difficult for third parties to detect. As qualitative research methods continue to reduce both systematic and human bias, this grouping of research designs will assume a higher position in the nine levels of EBL evidence.

IMPLEMENTING THE NINE LEVELS OF EBL EVIDENCE

Most librarians can appreciate the need to adhere to the levels of evidence due to the demonstrated relative strengths of each method. These comparative evaluations of the risks of different research methods in introducing human or systematic bias and the relative strength of each in determining causal relationships are familiar to past students in research courses. Thus, there has been little debate about this issue. It may seem discouraging, however, that librarianship does not offer a better representation of the more rigorous methods at the higher levels of evidence. There are three points to keep in mind on this issue. First, the Canadian Task Force on the Periodic Health Examination noted, in 1979, the ''lack of strong experimental evidence for or against most of the measures that we have considered.'' The task force further noted that ''Even evidence from cohort studies and case-control studies was infrequently found'' [172]. Secondly, there are still many current health care practices that lack sufficient evidence [173] to justify their continuation with enough confidence, although that number has been shrinking as the result of the EBM movement [174]. In some specialties—such as ear, nose, and throat surgery; anesthesiology; burns management; surgery; or emergency medicine [175–182]—researchers have concluded that an insufficient evidence base exists in those specialties for a variety of reasons. Yet, some of these researchers suggest that their respective evidence bases can be improved in spite of the current situation. Finally, librarianship may now have a plausible strategic framework through EBL to catch up quickly to the rigorous levels of EBM.

CONCLUSION

Every day health sciences librarians, like their colleagues in other health care specialties, make numerous decisions. These decisions range from the critical to the mundane. Upon reflection, readers may be reminded of some of these decisions: With what vendor should the library contract large sums of money for book, journal, or database services? Which staff-training program should the library employ? What library resources or services should be emphasized? What are the essential factors in deciding between print and electronic media? To what journals should the library subscribe? Which books should be bought? What tools best answer reference questions?

EBL offers a possible framework for making these decisions under conditions of uncertainty by providing a system for evaluating different forms of research evidence. By employing these methods that are familiar to many colleagues in other areas of health care, librarians also increase understanding about their unique challenges and invite collaboration from outside librarianship. The roads to EBM and EBHC in other areas of health care were full of obstacles, conceptual dead ends, and setbacks. By adapting the evolved core characteristics of EBM and EBHC that seem most applicable to librarians' circumstances, EBL can advance the mission of librarianship faster and more effectively. The foundations of EBL preceded the actual term, and health sciences librarians already are using most of the levels of evidence as outlined in this article. As EBL continues to evolve, librarians undoubtedly will find an increasing number of research projects conducted at the higher levels of evidence that are capable of facilitating practical decisions. Research studies are essential ingredients in making critical decisions. Although EBL provides a framework for focused thinking about decisions, it still requires librarians to think about their decisions. As Dauten states: ''Just because we increase the speed of information, doesn't mean we can increase the speed of decisions. Pondering, reflecting and ruminating are undervalued skills'' [183].

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